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The Multiple Semantics Hypothesis: Multiple Confusions?

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In this paper we discuss the issue of multiple versus unitary semantics. We argue that the notion of multiple semantics (as currently articulated) does not, in fact, represent a theory of semantic organisation but is, instead, an arbitrary conjunction of a set of independent assumptions which are either unmotivated or, if motivated, equally compatible with a unitary semantics hypothesis. Furthermore, the empirical evidence that has been cited as support for this hypothesis is equally compatible with variants of the unitary semantics hypothesis. A model of semantic processing—the Organised Unitary Content Hypothesis (O.U.C.H.)—that is able to account for reported patterns of dissociation of performance is discussed briefly.

INTRODUCTION

Shallice (1987) has forcefully argued that there is empirical evidence from the domain of cognitive neuropsychology which necessarily requires that we postulate "multiple semantic representation systems". This contention has been challenged elsewhere (Hillis, Rapp, Romani, & Caramazza, 1990; Humphreys & Riddoch, 1988; Riddoch, Humphreys, Coltheart, & Funnell, 1988) on the grounds that the empirical evidence on which it rests is not as secure as Shallice would have us believe and/or that the relevant

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evidence that is secure is not, in fact, inconsistent with a unitary semantics hypothesis.

In this paper it is argued that the hypotheses of multiple and unitary semantics, as currently formulated, are not sufficiently distinguishable so as to constitute truly empirical alternatives[1]. It will be shown that when we unpack the enthymemes on which the contrast between unitary and multiple semantics is based, the distinction between the two hypotheses dissolves into a set of *independent* questions about the nature of, and access to, semantic representations. More specifically, it will be argued that the notion of multiple semantics (as currently articulated) is simply the conjunction of a set of independent assumptions which are either unmotivated or, if motivated, equally compatible with a particular variant of the unitary semantics hypothesis—the Organised Unitary Content Hypothesis (O.U.C.H.). This discussion of the theoretical coherence, or lack of it, of current multiple semantics hypotheses will be followed by an assessment of the kinds of inferences that can justifiably be motivated by the putative modality-specific effects in semantic processing.

THE MULTIPLE SEMANTICS HYPOTHESIS

Shallice (1987; 1988a) cites three types of evidence in support of the hypothesis of multiple semantics:

1. the existence of modality-specific aphasias—that is, the existence of patients who show poor naming restricted to one modality of input despite evidence that access to semantic information is supposedly normal in that modality;
2. modality-specific semantic memory impairments—that is, disproportionate semantic memory difficulties in one modality over another; and
3. modality-specific priming effects—that is, the result in which a patient is helped more by a prompt in one modality than a prompt given in another modality.

According to Shallice, the existence of these modality-specific effects in semantic processing requires that we assume that meaning is represented in modality-specific systems: there is a visual semantic system, a tactile semantic system, a verbal semantic system, and so forth for the various modalities of information. Direct access to the information in a given semantic system is only possible through the modality in which the information is represented in that semantic system. Thus, for example, the visual semantic system is only directly accessible from visual stimuli. And, finally, although the semantic systems are distinct, they can communicate. In other words, information from one system is indirectly available to the other systems[2].

[1]We leave open the issue of whether the multiple and the unitary semantics hypotheses are empirically distinguishable "in principle".

A NEUTRAL DEFINITION OF "SEMANTICS"

If we wish to take seriously the claim that there may be different types of semantics—visual, verbal, kinaesthetic, tactile, and olfactory(?)—then we must consider in a more rigorous fashion what might be meant by such terms as "visual semantics" and "verbal semantics", and how these notions relate to other central aspects of semantic processing.

Although it is not easy, and probably not even desirable, to attempt to formulate a relatively precise definition of semantics which would generally be accepted as capturing the use of this term by the various communities of scholars and scientists who use it, there is certainly general agreement that, traditionally, by "semantics" has been understood the study of the relationship between "linguistic signs" and the "world". In the narrower context of the current debate, however, semantics seems to have acquired a more general meaning: by "semantics" is understood the relationship between any object or event (not only linguistic objects) and the general knowledge we have of those objects or events. For example, semantics is supposed to be involved in the case where one engages in a particular act with an object (say, sitting) if the object has a particular shape, is seemingly made of a particular substance(s), and is found in a particular context(s).

At this point one could object that "semantics" is being used to refer to very different sorts of things and it is, therefore, not surprising that there is much confusion about whether we need to postulate a single or multiple semantic systems. It could be argued that there is no interesting set of empirical issues here, but just a dispute about what is meant by semantics. This terminological "solution" would not do, however, as it fails to deal with what is, in fact, an important set of empirical issues—issues that have been raised in the experimental literature concerning apparent dissociations in semantic processing in different modalities of input and/or output (e.g. Beauvois, 1982; Beauvois & Saillant, 1985; Beauvois, Saillant, Meininger, & Lhermitte, 1978; Riddoch & Humphreys, 1987; Warrington,

[2]It is not entirely clear what is meant by "communicate" in this context. We will assume that what is meant is that the representation activated in one semantic system can address corresponding representations in other semantic systems. Thus, for example, the object tulip would first activate a semantic representation in the visual system and this, in turn, would activate semantic representations of tulip in the verbal, tactile, and whatever other semantic systems are subsumed by this hypothesis.

1975). Therefore, we will discuss the issue of semantic representations in the most neutral fashion possible, without mention of reference, extension, intention, and the like—central aspects of any nontrivial theory of meaning. The central issue under discussion will concern the nature and form of those representations (whether or not they may properly be considered to be semantic) that are assumed to mediate between modality-specific representations of stimulus inputs and modality-specific representations of the task-determined responses. These mediating representations will be referred to as semantic representations.

Two examples may help clarify the use of the term "semantic representation" used in this paper. Consider first the case of object recognition. It is assumed that perceptual processing of an object results in a viewer-centred representation of the visible surfaces of the object (2½-D sketch; Marr, 1982) which in turn serves as the basis for the activation of an object-centred representation (3-D model) of the object. The latter representation, in turn, serves to activate more abstract, perceptual, and functional predicates (e.g. has a back, has a seat, seats one, etc.) as well as more general properties (e.g. artifact) associated with the object (Caramazza, Berndt, & Brownell, 1982). The information represented at this last level determines the types of responses that are appropriate to the stimulus item—e.g. sitting on it. On this account of the process of object recognition, the semantic level corresponds to the information that is accessed from the 3-D level representation of the object. It should be noted that the 3-D level representation itself is *not* part of its semantic representation: its function is to access semantic representations. In this sense, the 3-D level representation of an object corresponds roughly to the modality-specific representations of words—lexical-orthographic and lexical-phonological representations.

Consider now the case of reading. Here, it is assumed that perceptual processes result in a representation of the abstract letter identities that comprise the word which, in turn, serves to activate an orthographic-lexical representation. This representation then serves to activate a set of properties (e.g. artifact, has a back, has a seat, etc.) and functions (e.g. seats one) associated with the referent of the word. The latter information serves to constrain the type of responses that are appropriate to the stimulus word, such as a particular phonological response or a particular action (e.g. the presentation of the written sentence, *Please sit on the chair* resulting in the action of sitting on a chair as opposed to a stool, say). In this case, the semantic level of representation corresponds to that level where information specifying the properties and functions of the referent of the word are specified. Note that on this "neutral" formulation of semantic representation we are not necessarily committed to the view that the semantic representation associated with an object, such as a chair, is the same as that associated with the name of the object—in this instance, the word *chair*.

All that this formulation of semantics commits us to is that the semantic information accessed by objects or words must be of a *sort and quantity* to support correct naming and use of objects. This means, at the very least, that semantic representations must contain information about both perceptual and functional properties of the referents of a term or object. Thus, for example, the meaning of a term is not just the set of perceptual attributes (e.g. has a back, has a seat, etc.) that characterise its referent nor just the information concerning its class membership (e.g. furniture) or function (e.g. for sitting). The meaning of a term includes all of these things.

UNPACKING THE MULTIPLE, MODALITY-SPECIFIC SEMANTICS HYPOTHESIS

The first question to consider is what is meant by "multiple semantic systems". One interpretation of this expression is that in the cognitive system there are various autonomous, self-contained semantic systems each of which contains full semantic descriptions of objects or words, as the case may be, each accessed via a different modality of input (what Riddoch et al. [1988] have labelled the "input" account of the multiple semantics hypothesis). In this account, the representation of an object in the visual semantic system would contain *all* the information that is assumed to comprise the semantic description of that object. The same would be the case for the representation of objects and words in the other semantic systems. Thus, for example, the representation of the word *tulip* in the verbal semantic system would contain all the information that comprises the meaning of that term—perceptual attributes, function, category membership, and so forth. Similarly, the representation of the object tulip in the tactile semantic system would specify all the properties that constitute the meaning of that object, including functional and class membership information.

Although this interpretation of what is meant by multiple semantic systems is certainly a plausible reading of the description offered by Shallice (1987) in the paper that set this whole debate in motion, he (Shallice, 1988a) has since explicitly rejected this position, claiming that it was not his in the first place. This notion of multiple semantics—in the sense of self-contained, duplicate semantic systems, each containing all the information necessary to capture what we intend by a word or object[3]

[3]We have great difficulty using the locution "meaning of an object" with the analogous sense carried by the locution "meaning of a word". We do so under "protest" and only in order to give as unbiased an interpretation of this literature as we can. Obviously, asserting that a word has such and such a meaning, in the sense in which an arbitrary sign may be used to refer in the world, is not something we normally assert of objects (except in the case where an object has, in fact, an arbitrary relation to the world—e.g. Sherlock Holmes: Watson, what do you take to be the meaning of that chair in the middle of the room?).

having a certain meaning—is not an especially attractive one; it is a totally ad hoc position that, to our knowledge, has not been articulated beyond the mere label "multiple". It seems clear enough that, short of someone articulating this position in enough detail to provide it with some content, we do not need to consider it in any detail.

We are left, then, with a very different issue—one concerning the nature and organisation of a presumed *heterogeneity* of semantic information. Although it is uncontroversial that the meaning of a word such as *chair* presumably includes information regarding appearance, function, category membership, texture, etc., it is not at all obvious what might be the consequences of this diversity. Given the assumption of heterogeneity of semantic information, one may be tempted to conclude that the different kinds of information are organised into distinct subsystems. This is precisely the step taken by proponents of the multiple semantics hypothesis. Thus, the claim of modality-specific semantics is best understood as a claim—or set of claims—regarding the organisation and processing of heterogeneous semantic information. The multiple semantics hypothesis assumes that the semantic system is organised into a set of interconnected modality-specific *subsystems* each containing only part of the semantic description of a term, and each only accessed directly, in a "privileged" manner, from a specific modality of input (Shallice, 1988a; 1988b). Thus, for example, information in the visual semantics system is accessed directly *only* from the structural description of visually presented objects. This information may also be accessed for both visually and aurally presented word stimuli. However, in the latter case, access is mediated by prior access to relevant semantic information in the verbal semantics system (see Fig. 1). We will refer to the assumption of a direct link between a particular type of input representation—lexical vs. object description—and a particular semantic subsystem—verbal vs. visual—as the *assumption of privileged accessibility*.

A further implicit assumption, on a particular reading of the multiple semantics hypothesis, is that the modality specificity of the hypothesised subsystems concerns the content and/or the format of representation in these subsystems. The claim that a semantic representation is heterogeneous with respect to the information represented (that there are different bits or kinds of information) is neutral on the issue of whether the heterogeneity concerns the format or the content (or both) of the representation. Thus, for example, it could be hypothesised that the information specifying the perceptual properties that are needed for something to be a chair, or the information that a chair is a seat for one, is represented in modality-neutral symbolic format or in modality-specific (e.g. pictorial, kinaesthetic, etc.) format. In both cases—modality-neutral and modality-specific format—the semantic representation is heterogeneous with respect

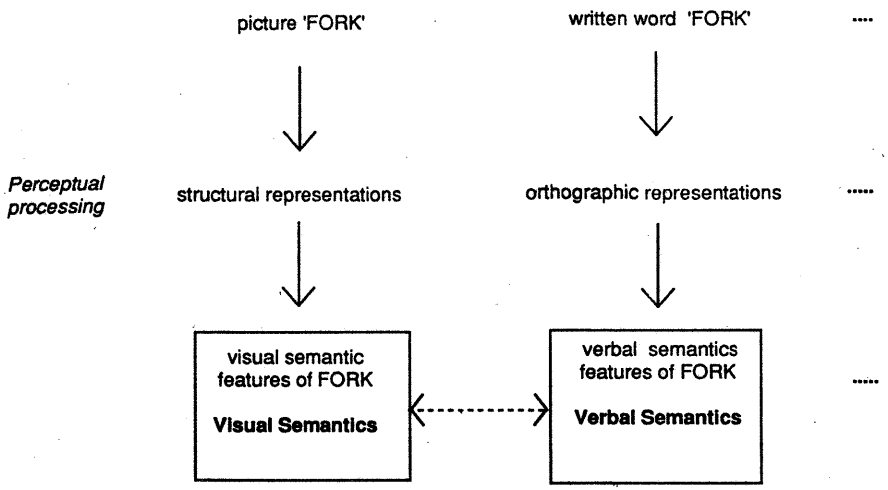

FIG. 1 A schematic representation of multiple modality-specific subsystems account of semantic representation.

to the *content* of the information that is represented—visual-perceptual versus functional properties, say. But only in one of the two cases is the semantic representation heterogeneous with respect to the *format* in which information is represented—"pictorial" or "visual" versus "propositional" or "verbal", say. One could entertain the hypothesis that the semantic system is organised into subsystems under either reading of the "heterogeneity of representation hypothesis". The only difference is that in one case the organising principle for semantic subsystems is specified in terms of "content of representation", and in the other it is specified in terms of "format and content of representation". Although Shallice is less than clear on this matter, it is possible to infer from his discussion of the distinction between visual and verbal semantics that he conflates the issues of content and format of representation. Thus, in introducing the topic of modality specificity he does so by reference to ". . . an extensive debate within cognitive psychology . . ." in the 1970s. He (Shallice, 1988b, p. 291) formulates the issue thus: "Some argue that items are represented at the 'semantic' level in a single amodal system (Chase & Clark, 1972; Seymour, 1973; Potter, 1979). To others, separate systems for verbal, visual, and maybe other modalities are involved (e.g. Paivio, 1971) or even these and an abstract one, too (Anderson, 1980)." He goes on to suggest that neuropsychological evidence may be relevant to *this* issue, and proceeds to present what he considers to be evidence in favour of the modality-specific hypothesis of semantic representation. In the absence of further clarification we must assume that the modality-specific hypothesis advocated by Shallice is not different from that espoused by Paivio (1971), who clearly

assumes that visual semantics is represented in a different format from verbal semantics—visual/imagistic and symbolic/propositional, respectively.

As will be argued at length later, it is our contention that neither of the principal assumptions of the multiple semantics hypothesis is justified. The first assumption—that regarding the notion of direct or privileged accessibility to certain parts of a semantic representation from particular inputs—is equally compatible with either unitary or multiple semantics hypotheses, albeit in different forms for each. The second assumption—that regarding a presumed relationship between the content and the format of representations—is supported neither by theory-internal considerations nor by empirical evidence. Although recent discussion of the two hypotheses have focused on the issue of content (see, for example, Humphreys & Riddoch, 1988; Riddoch et al., 1988), we have chosen, for the sake of completeness, to discuss both the hypothesis of different formats and that of different contents of representation for the proposed semantic subsystems. We conclude with a discussion of the implications of various patterns of impaired performance for hypotheses about semantic representation and organisation.

WHAT ARE "VISUAL" AND "VERBAL" SEMANTICS?

Although in recent years there has been much discussion of the issue of multiple semantics (see, for example, the special issue of *Cognitive Neuropsychology* edited by Job and Sartori, 1988), the very notion of multiple semantics remains less than clear. In what follows we discuss various possible interpretations of the multiple semantics hypothesis in the specific context of a presumed distinction between visual and verbal semantics. There are at least four possibilities.

As already mentioned, one interpretation of what is meant by "visual" and "verbal" semantics are the sets of semantic information that are accessed when the *stimuli* are, respectively, an object (or picture) or a word—previously referred to as the "input" account (Riddoch et al., 1988). On this account, the semantic information accessed by a word stimulus is separate from that accessed by the visually presented object named by the word—this view entails distinct, autonomous semantic systems associated with different input representations (say, the 3-D level representation of an object or the lexical-orthographic representation of a word). In this case the labels "visual" and "verbal" do not serve to capture distinctions about the content (or form) of the information specified in a semantic representation (e.g. visual-perceptual properties versus functional properties) but, instead, serve to identify the modality of the stimulus accessing a semantic representation for that modality. In other

words, what is "visual" about visual semantics is the modality of input of the stimulus object, and what is "verbal" about verbal semantics is the fact that the input stimulus is a word. As noted earlier, this account will not be given serious consideration.

Another interpretation of "visual" and "verbal" semantics is one in which these terms suggest particular modality-specific contents. We will call this position the *modality-specific content hypothesis*. On this account, visual semantics would refer to that set of information concerning visually specified attributes of objects (e.g. the shape of an object) and visually specified associations among objects—the type of associations formed when we see objects together. Because, on this hypothesis, the content of the information in the visual semantic system concerns only visually specified information, it is possible (though not necessary) to further assume that the *format* in which this information is represented is visual/imagistic, as proposed by Paivio (1971). By extension, we may assume that information in the tactile semantic system is represented in a tactile format. As for verbal semantics, the assumption is that it is supposed to refer to linguistic information which is represented in a symbolic or propositional format. Thus, for example, the fact that the information that a tiger is an animal is conveyed linguistically would lead to the storage of this knowledge in a symbolic format in a verbal semantic system. We will call this hypothesis the *modality-specific format hypothesis*. The latter two hypotheses considered here make two further assumptions:

1. access to semantic information from a given modality (say, seeing an object) always results first in the activation of modality-congruent semantic information (say, visual semantic information) and only subsequently in the activation of other semantic information (e.g. tactile, verbal, etc.); and
2. the activation of lexical-phonological and lexical-orthographic representations for production is necessarily mediated by the "verbal" semantic system (see Fig. 1).

Another possible interpretation of the multiple semantics hypothesis is one we will call the *modality-specific context hypothesis*. This hypothesis assumes that visual and verbal semantics refer to, respectively, the information that is acquired in the *context* of visually presented objects or through language[4]. On this hypothesis, the information represented in the

[4]Warrington (1975, p. 656) would seem to suggest this in stating: "That is, a particular concept, say 'canary', would be represented in two semantic memory hierarchies, the one primarily visual and the other primarily verbal. Developmentally this is not an entirely absurd suggestion; the visual world of an infant is well differentiated long before language is acquired. If this speculation holds then it follows that verbal concepts during acquisition are not mapped directly on to previously existing visual concepts. Thus in the adult where dissolution of function can be observed the double dissociation of visual and verbal semantic memory would be explicable".

visual semantic system does not necessarily refer to visual properties of objects or to information that may be represented in a visual format. Similarly, the information represented in the verbal system need not concern exclusively abstract, linguistically expressed relations. Thus, for example, if the (presumably) "visual" information that tigers have stripes was acquired through language then this information would be stored in a verbal semantic system along with other verbally acquired information such as the fact that tigers are mammals[5]. As in the case of the modality-specific content and format hypotheses, the assumptions are made that:

1. the visual and verbal semantic systems are accessed directly only through the (visual) object and lexical representations, respectively, and only subsequently (and indirectly) is the semantic information in other systems accessed; and
2. the activation of output lexical representations is always mediated through the verbal semantic system (see Fig. 1).

It should not go unnoted that because of the heterogeneity of information that may be included in each of the putative semantic systems (e.g. a tiger has stripes, a tiger is a mammal), it is problematic to distinguish context-specific semantic systems in terms of the format of representation. Thus, for example, it makes no sense to think of the visual semantic system as representing information in a visual/imagistic format, since presumably this system also represents nonvisual abstract properties of objects acquired in a "visual" context. This observation becomes apparent if we consider Shallice's (1988a, p. 296) statement concerning the types of information that might be represented in the semantic system: "For a visually presented object, they include the sensory qualities not directly observable, the other objects that might be expected in its vicinity, the appropriate ways of using it, its function, the behaviours it is likely to have, one's emotional attitude to it, as well as a host of more abstract possibilities." From statements such as these, it is clear that it would be impossible to represent all the information in the visual semantic system in a visual/imagistic format—for example, it is difficult to see how this could be done for one's emotional attitudes to an object. In other words, it is not possible to have a coherent theory of multiple semantics that distinguishes between

[5]A major problem with this view is that the theory is totally unconstrained and therefore without empirical content. We can easily imagine getting information about the perceptual properties of an object through language as when we describe an object as being round, say. Does this mean that perceptual predicates are part of verbal semantics? If this were the case, and it would seem to be so from the description of verbal semantics provided by Shallice (1988a), we would not be able to distinguish between the contents of verbal and visual semantics since we do not know what particular experiences an individual has had—a rather unsatisfactory situation.

different semantic systems on the basis of format of representation *and* at the same time includes within any given format-specific system the disparate sorts of information proposed by Shallice. Apparently, the format of representation of information in each system must either be "amodal" or of mixed types.

Which of these hypotheses is the one proposed by Shallice? As already mentioned, Shallice (1988a) has explicitly disavowed the "input" interpretation of the multiple semantics hypothesis. This leaves the modality-specific format hypothesis, the modality-specific content hypothesis, and the modality-specific context hypothesis. Unfortunately, it is not clear which of these hypotheses is being proposed. We have argued that the context in which the multiple semantics hypothesis has been discussed would lead one to think that it is the modality-specific *format* hypothesis that is being proposed. However, there are other aspects of Shallice's discussion of the multiple semantics hypothesis which lead one to infer that the proposed hypothesis is the modality-specific *context* hypothesis. Regardless of the particular view espoused by Shallice we will examine what appear to be the fundamental assumptions underlying each of these three hypotheses.

ON THE FORMAT OF SEMANTIC REPRESENTATIONS

One way to conceive of the organisation of semantic information is in terms of the format of representation. Within this framework, the only coherent formulation of the multiple semantics hypothesis is in terms of what we have labelled the *modality-specific format hypothesis*. This hypothesis distinguishes between visual and verbal semantics by reference to the format in which semantic information is represented—in visual/imagistic and symbolic/propositional formats, respectively. The contents of the respective semantic systems differ in that for visual semantics the stored information consists of those aspects of a term that are visually based (e.g. its shape, its visual context), whereas for verbal semantics the stored information consists of those aspects of a term that are abstract or linguistically based (e.g. class membership).

For contrastive purposes consider the *modality-specific content hypothesis*. This hypothesis assumes that semantic information is represented in a modality-neutral (amodal, symbolic) format. In addition, the information represented in this system would be organised into subsystems defined by the type of content represented. In other words, this latter hypothesis assumes that the content of a semantic representation (predicates referring to visual properties, tactile properties, functional properties, etc.) determines the organisation of information in the semantic system. And, finally,

it is also assumed here that there is a privileged relationship between types of input representations (e.g. 3-D level representation of an object) and the content of semantic representations (e.g. the symbolically represented perceptual properties that define an object).

Note that the two hypotheses assume that there is internal structure to the semantic system—both assume that the semantic system is organised into subsystems defined by the content (e.g. visual properties) of the information represented. The only difference between the two hypotheses concerns the format used to represent different subsets of semantic information: in one case the format is modality-specific; in the other it is modality-neutral or symbolic. The question to be addressed is: are there any reasons for thinking that different subsets of semantic information are represented in different formats?

Consider first the issue of whether there are theory-internal reasons for such a distinction—that is, reasons motivated by considerations of the general architecture of a cognitive system or by considerations of the type of computations that must be performed over some type of representation. If such theory-internal reasons were ever adduced in support of the putative distinction, we are not aware of them. The distinction constitutes no more than an arbitrary assertion.[6]

If there is no compelling, theory-internal motivation for proposing different formats of representation for the semantic information concerning visual and functional properties, respectively, is there at least empirical motivation for this distinction? A number of authors have raised doubts about whether it is possible to articulate empirically testable claims concerning the format(s) of representations independently of specific claims regarding the content of the representations and the processes that they are involved in (see Anderson, 1978; Snodgrass, 1984; and Glucksberg, 1984, for a thorough discussion of the difficulties involved). Yet it has been argued that neuropsychological results showing modality-specific effects provide evidence in favour of the hypothesis that semantic information is stored in different formats of representation (Shallice, 1988a; 1988b). This suggestion seems to be without basis. That is, given the level at which the alternative hypotheses have been formulated, the experimental evidence does not distinguish between them. Consider the putative evidence.

[6]We note here that if one were to consider that the distinction between visual-pictorial and symbolic-propositional format of representation for parts of the semantic description of a term is a legitimate empirical matter, then the issue of the format of the representation of what is putatively "verbal" semantics should also be an empirical matter to be decided by experimentation. In other words, multiple semantics theorists should seriously entertain the possibility of demonstrating that there are two types of verbal semantics: one represented in a phonological code, the other in an orthographic code.

We have noted that the types of evidence which have been cited (Shallice, 1987, p. 112) in support of the multiple, modality-specific semantics hypothesis include: "characteristics of the modality-specific aphasias (Beauvois, 1982), the existence of modality-specific priming in semantic access dyslexia (Warrington & Shallice, 1979), and modality-specific aspects of semantic memory disorder (Warrington, 1975; Warrington & Shallice, 1984) . . .". Leaving aside the fact that some of the evidence has been called into question (see Riddoch et al., 1988; Hillis et al., 1990), none of these three types of dissociations between the sorts of information available to patients even remotely requires that we accept the hypothesis that different subsets of semantic information are represented in distinct modality-specific formats (e.g. visual/imagistic vs. symbolic/propositional vs. tactile).

Even if we accept that it is possible to have access to visual semantic information, without having access to verbal semantic information, for example, the strongest conclusion that is possible (and even this will be questioned shortly) is that (1) the semantic system is organised into subsystems defined by the content represented (e.g. visual properties vs. relational properties) and (2) the content in a semantic subsystem is differentially accessible as a function of the modality of input—that is, there is a privileged relationship between content type (e.g. visual-perceptual properties) and modality of input representation (e.g. 3-D level representation). Thus, for example, the results showing modality-specific semantic memory impairments may be interpreted within the format-neutral content-specific hypothesis as resulting from damage to a content-defined semantic subsystem as discussed earlier. In other words, this result, and the others cited in this literature, do *not* require that the damaged information be represented in a modality-specific format.

In short, then, it is clear that we do not have empirically compelling reasons for requiring that the organisational principles of the semantic system should be specified in terms of the format of the information represented. If one wanted to entertain the hypothesis that the semantic system is organised into subsystems each representing modality-specific information (e.g. all tactile information), one could do so strictly on the basis of the *content* of the information represented and without being committed to the view that the format in which this information is represented is modality-specific (e.g. in some "tactile" form, "visual" form, and so forth). At best, then, the cognitive neuropsychological evidence may be taken as suggesting that one aspect of the internal structure of the semantic system is that it is organised into subsystems defined by the type of information represented. However, as we shall see, not even this weaker conclusion is warranted by the triad of result types cited by Shallice (1987).

ON PRIVILEGED ACCESSIBILITY

What is the motivation for assuming that the semantic system is organised into subsystems defined by type of modality-specific content? The main reason would appear to be that the empirical evidence requires privileged access from a particular modality of input to a subset of the semantic information that defines the meaning of a term. The data suggest that it is possible to access part of a semantic representation (e.g. "visual" semantics) without necessarily having access to other parts of the semantic representation of a term (e.g. "verbal" semantics). Although this situation arises only in conditions of brain damage, it has been claimed that it is made possible by the fact that the semantic system is organised in such a fashion that its constituent parts may "dissociate" under conditions of brain damage[7]. The modality-specific content hypothesis would appear to be consistent with such observations. However, we will argue that even if one were to grant that acceptance of the principle of privileged access is required by the empirical evidence cited by the proponents of multiple semantics, the principle could be instantiated in different forms, not all of which require that the semantic system be organised into modality-specific subsystems. In other words, one could accept the principle of privileged accessibility of different parts of semantic representations without being committed to the view that semantic information is organised into modality-specific subsystems. To give substance to this assertion we will examine the role of privileged access first within a modality-specific content framework and subsequently in terms of a single amodal semantic system hypothesis.

[7]There is an important distinction that should be drawn between functionally vs. neuroanatomically significant principles of organisation. One could imagine, for example, that the symbolically represented perceptual predicates of visual properties of objects are neuroanatomically localised in tissue that is spatially adjacent to occipital regions, while the perceptual predicates for other properties of objects are localised in other areas of the cerebral cortices. We would then have a neuroanatomically based organisation of semantic information which would give rise to dissociations of performance when different regions of the brain are selectively damaged. However, even in this extreme case, it does not follow that we must adopt a model of semantic organisation at the functional level which assumes that semantic information is organised into modality-specific subsystems. It could turn out that the neural segregation of semantic information does *not* have any functional consequences for normal processing. This point may better be appreciated by analogy to a computer system. We can imagine a situation where bits of information which constitute elements of a whole unit are stored in different physical locations in memory. Thus, in order to process the unit in question, all its component elements must be activated, irrespective of the physical location where they are stored. For example, if we were to assume that in the string $A_1B_1C_1D_1A_2B_2C_2D_2A_3B_3C_3D_3$ the position of a letter represents a physical location and that the subscripted letter represents the information content stored, then the set $\{A_1, A_2, A_3\}$ represents the information that defines the unit A. In this example, the physical location where information is stored plays no role in determining the functional role of that information.

Depending on the type of processing claims we are willing to entertain, it could be argued that there are privileged relationships between particular forms of inputs and subsets of the information in a semantic representation (or subsystems of a semantic system). Thus, for example, it could be argued that those parts of the semantic representation that specify the perceptual properties of the referent of a term are more easily accessed when the stimulus is an object than when it is the name of the object. More precisely, the claim would be that the subsystem of knowledge that represents perceptual properties of objects is more easily accessed through a perceptual description of the object—e.g. the 3-D level on Marr's theory—than through the lexical-orthographic or lexical-phonological representation of the name of the object. It is critical to note at this point that the claim of *privileged accessibility* of parts of a semantic representation or of a subsystem of the semantic system does *not* depend on specific assumptions that the format of semantic representations. That is, privileged accessibility is possible given either heterogeneity of format or content of information. All that is required for this claim to be viable is that there be some principled way of specifying putatively significant modality-specific distinctions within the semantic system. For example, subsystems for visually acquired information could be distinct from subsystems for tactually or auditorily acquired information; alternatively, subsystems containing information represented in a visual/imagistic code could be separate from subsystems containing information represented in tactile codes or symbolic codes. Thus, putative "boundaries" between subsystems could be specified either in terms of the content or the format of parts of a semantic representation. Thus, the principle of privileged accessibility of subsets of semantic information from particular input representations is a critical assumption made by proponents of multiple semantics quite independently of the issue of format.

A related (and, for our purposes, crucial) feature of the multiple semantics model is that the semantic information in a subsystem can be accessed *directly* only through a "modality-congruent" input representation. The semantic information accessed in a particular subsystem then serves to activate the relevant semantic information in other subsystems. Thus, for example, the information in the "visual" semantic subsystem can be accessed directly only from the visual representation computed for a visually presented object (or picture); once the "visual" semantic information is accessed it, in turn, provides access to semantic information in the "verbal", "tactile", "olfactory", and "kinaesthetic" subsystems. (A schematic representation of this model is shown, for expository purposes, in Fig. 1). In short, then, this view instantiates the notion of "privileged

accessibility" by assuming direct (and, in fact, exclusionary) links between particular forms of input representations and organised subsets of the semantic system—the modality-specific content hypothesis.

It is possible, however, to instantiate the notion of "privileged accessibility" in such a way as not to require that the semantic system be organised into modality-specific subsystems with exclusionary access from modality-congruent input representations. This view assumes that a semantic representation may be accessed directly in its totality from any of the input representations that are linked to it. (A schematic representation of this system is shown in Fig. 2.) Thus, for example, on this account the semantic representation that is accessed directly for the word "fork" is the *same* as that accessed by a picture of the object "fork". How, then, assuming for the moment that there is empirical motivation for it, do we get "privileged accessibility" for modality-congruent information?

The account we will offer here assumes that privileged accessibility is an asymmetrical property of the semantic system: it only applies to perceptual predicates[8]. More specifically, privileged accessibility is assumed to be an

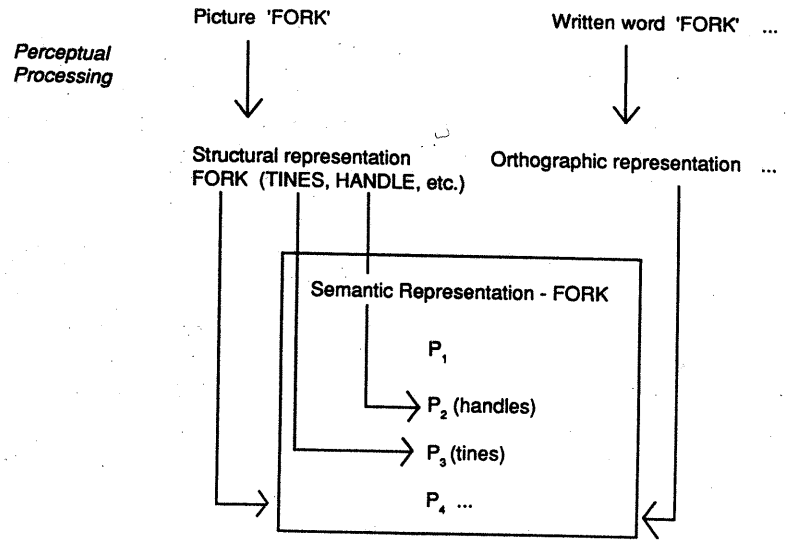

FIG. 2 A schematic representation of a unitary semantics account of semantic representation (P_x refers to predicate x).

[8]If instead of assuming that privileged accessibility is *asymmetrical* we assumed that it is *symmetrical*, we would expect not only the patterns of performance reported in cases of "optic" and "tactile" aphasia, but also a pattern of dissociation in which only abstract, symbolic information (and not perceptual information, such as visual or tactile attributes) is accessible from verbal input, when perceptual information *is* available from tactile, visual, and other sensory inputs. The only reported dissociation [illegible]

accidental byproduct of the fact that perceptual predicates are associated with referents in the world. To illustrate this claim, consider once again the case of access to the semantic system from the word and the object "fork". The word "fork" bears an *arbitrary* relationship to its meaning—its referent in the world, its function, its relationship to other terms in the language. It is a matter of historical accident that the word "fork" is used to index the particular meaning it has in our culture; the word "table", or "elephant", or "gruck", could have done as well. A different situation arises in the case of the object "fork". The object does *not* have an arbitrary relationship to its meaning (if one can talk of meaning in the same sense in which we talk of meaning for words). Instead, various aspects of the meaning of the object—such as the fact that we can eat with forks, the facts that forks have tines and a handle, can be moved, and so on—are dependent on properties of the object. Some of the latter properties are perceptually salient. That is, certain semantic properties of an item such as "can be used for spearing" are related to particular perceptual features of the object (in this case, the tines).

The fact that perceptual predicates in the semantic representation of an object are linked to perceptual features of the object may have important consequences for the way in which semantic representations are accessed by structural descriptions of objects. It could be hypothesised that not only does the perceptual description of an object *as a whole* serve as the access code for the semantic representation associated with the object, but that *parts* (perceptual features) of the object can serve as the access codes to perceptual predicates in the semantic representation of the object. For example, the object "fork" may access its corresponding representation in the semantic system. However, perceptually salient parts of the fork may also access their semantic representations: the feature "tines" may access a representation concerning the meaning of tines; the same for handle, etc. Consequently, *access to a semantic representation through an object will necessarily privilege just those perceptual predicates that are perceptually salient in an object* (see Fig. 2). It is possible, in other words, to instantiate the notion of "privileged accessibility"—restricted to perceptual predicates, to be sure—without requiring that the semantic system be organised into modality-specific subsystems.

The implication of the foregoing is straightforward. If the (only) reason for postulating that the semantic system is organised into modality-specific subsystems is because of the need to have "privileged accessibility" for perceptual predicates, then it is clear that we need not draw this conclusion. There is at least one alternative model of semantic processing—the Privileged Access Unitary Content Hypothesis (P.A.U.C.H.)—that allows "privileged accessibility" without requiring that the system be organised

ON PRIVILEGED RELATIONSHIPS

We have tried to show that there is a set of independent assumptions—the formats in which semantic information is represented, the organisation of this information into subsystems, and the relative accessibility of semantic information from a given modality of input—that characterises the most plausible reading of the multiple, modality-specific semantics hypothesis. We first challenged, on the grounds that there is no theory-internal or empirical motivation for it, the assumption that semantic information must be heterogenous with respect to the format in which it is represented; we then demonstrated that semantic information (whether in a modality-specific or a modality-neutral format) does not need to be segregated into subsystems. This latter argument involved showing that the notion of privileged accessibility of perceptual information from modality-congruent inputs—the only assumption that seems to be supported by the available evidence (see Riddoch et al., 1988; Hillis et al., 1990)—is also consistent with a view of semantics (the P.A.U.C.H.) model) which does not require modality-specific subsystems. Recall, however, that an additional piece of evidence cited in favour of the modality-specific multiple semantics hypothesis is the observation that there are patients who, although seeming to present with semantic difficulties in processing words, are nonetheless able to use appropriately (or to mime appropriately the use of) the very objects they cannot name. For present purposes, the relevant aspect of this observation is that there seems to be a *privileged relationship* between information about the form and information about the use of an object. That is, the association between the perceptual structure of an object and its function may be preserved even when the association between the perceptual structure of an object and its name is impaired.

The crucial issue here concerns the manner in which the principle of privileged relationships is instantiated in a processing model of semantics. Within multiple semantics accounts it would appear that this principle is captured by assuming that there are distinct modality-specific semantic systems in which stored information acquired in different contexts is stored—the modality-specific context hypothesis. Specifically, information concerning form and function acquired in the same context are stored in visual semantics while information acquired in language contexts is stored in verbal semantics. We will argue, however, that the principle of privileged relationships may be easily accommodated within a unitary content semantics hypothesis. That is, the notion of privileged relationships is compatible with particular instantiations of the unitary content thesis.

Consider once again the P.A.U.C.H.—Privileged Access Unitary Content Hypothesis. Recall that the P.A.U.C.H. is a modality-independent unitary semantics hypothesis which assumes that access to a semantic

representation by a visually presented object will privilege access to perceptually salient features of the object, even though there is a single, undifferentiated semantic representation for the visually presented object and the word for that object. How can we capture the notion of privileged relationships within a unitary content account of semantics? One possibility—the Privileged Relationship and Access Unitary Content Hypothesis (P.R.A.U.C.H.)—assumes that semantic representations are internally structured. Specifically, the assumption is made that the links relating the various component features that jointly define the meaning of a term are of unequal strength. On this view, we could assume, for example, that the links relating those semantic features that specify the structural properties of an object (e.g. chairs have backs) to those other semantic features that specify its function (e.g. chairs are for sitting) are stronger than the links relating the semantic features of structural properties to other semantic properties such as category membership (e.g. chairs are furniture). One implication of this assumption would be that damage to a semantic representation could result in differential impairment of the relations among the component features of the meaning of a term—e.g. relatively better preserved information about structure/function relations than about structure/category relations. (Parenthetically, we note that the proposed relationships between perceptual and action information differs from other accounts in the literature (e.g. Riddoch & Humphreys, 1987) in that these refer to a direct relationship between gestures and structural descriptions whereas our account specifically concerns the relationship between *semantic* representations of perceptual predicates and canonical function.)

Is there independent motivation for assuming different degrees of strength in the links relating the various predicates that comprise the meaning of a term? Two considerations may be offered in this regard. We begin by noting that this assumption represents a simple extension of a more general principle concerning the structure of semantic representations; viz., the principle that relations among semantic units may be graded. This principle has already been invoked in other contexts through the assumption that the individual semantic predicates that comprise the meaning of a word may have unequal definitional roles—some semantic predicates are more important in defining the meaning of a term than others, even though they all constitute part of the meaning (see, e.g., Smith & Medin, 1981). For example, "has a handle" and "concave upward" are both part of the meaning of cup, but the latter feature is more important than the former in determining the meaning of cup—cups need not have handles (at least in the U.S.A.), but they must be concave upward. The point is that it is a fundamental assumption of the type of semantic theory considered here that meanings have a "textured" structure reflecting the internal organisation among the basic elements that comprise

a semantic representation (Caramazza et al., 1982). For this class of theories, an important organisational principle is the notion of "degree of X", where X can refer to the contribution a predicate plays in determining the meaning of a term or, more importantly for present purposes, the strength of association among semantic predicates. Thus, the instantiation of the assumption of privileged relationships in terms of the notion of strength of links among semantic predicates constitutes a natural extension of a basic principle of semantic theory.

Assuming that the notion of "degree of relationship", as outlined here, represents a natural aspect of semantic theory, we may ask what determines the differential link-strength among the predicates that comprise the meaning of a term. More specifically, is there reason for assuming that the semantic predicates that define canonical actions with an object are more closely related to the semantic predicates that specify its structural (visual) properties than they are to the semantic predicates concerning other properties of the object, for instance its characteristic sound? The obvious reason for accepting this assumption is that action patterns with an object are not independent of the structural properties that define it. In other words, the shape of an object determines (to a considerable extent) the canonical action pattern associated with it—e.g. the action patterns associated with a fork are drastically different from those associated with a soccer ball, in large measure *because* of their respective shapes. It would seem, then, that there are grounds for assuming differential link strengths among semantic predicates, and more specifically, between the structural (visual) properties of an object and the canonical action pattern associated with it.

In this section we have shown that the assumption of privileged relationships among semantic predicates may easily be accommodated within a unitary content accounts of semantics. Thus, if the reason for proposing that the semantic system is organised into modality-specific subsystems (in the form of the modality-specific context hypothesis) is in order to capture the principle of privileged relationships, then it is clear that we need not do so. There exists at least one form of the unitary semantics hypothesis—the P.R.A.U.C.H. model—that allows privileged relationships among semantic predicates without requiring that the semantic system be organised into modality-specific subsystems.

ON THE EMPIRICAL STATUS OF MODALITY-SPECIFIC AND MODALITY-NEUTRAL SEMANTICS HYPOTHESES

We have gone on at great length in trying to articulate what role such notions as "modality-specific", "multiple semantics", "verbal semantics", "visual semantics", and "semantic subsystem" may play in a coherent model of semantic processing. We have shown that these general constructs are too poorly specified to be of much use for a model of semantic processing or as a guide for experimental investigation. In each case it has been shown that there are radically distinct models that may be subsumed under each of these gross notions. At best, then, much of the discussion about "multiple semantics" is only nominally (in a nonexplanatory way) related to various experimental results. That is, such notions as "visual semantics" constitute no more than mere labels for observed dissociations of performance.

As an example of this reification of dissociations into types of semantics, consider the case of "visual semantics". The notion of "visual semantics" has been used in the context of the following type of situation. A patient who cannot name objects only when these are presented in the visual modality but who can perform an adequate mime for the object in this same modality, is said to have "intact" *visual* semantics (Beauvois, 1982). What allows the inference in such cases that there are distinct semantic systems, one "visual" and the other "verbal"? (For the sake of exposition the discussion will focus on the use of the miming task as a means of getting supposedly relevant evidence, but we could as easily have discussed other tasks—see, for example, Rapp & Caramazza, 1989). The reasoning behind these conclusions appears to go something like the following:

1. The very fact that the naming difficulty in these patients is restricted to one modality (or that at least one modality is unaffected by damage) must mean that the mechanisms of lexical retrieval for output are normal, as must be the semantic representations that are needed to support naming performance.
2. These patients can be shown, through good performance on such tasks as miming, to have "normal" object recognition in the modality in which naming is impaired.
3. Since normal performance of tasks such as miming would seem to require "semantic appreciation" of the object, we must conclude that the semantic representation associated with the modality of input is also intact.
4. Therefore, the only possible explanation that is consistent with conclusions (1), (2), and (3) and the fact that naming of objects is impaired (in the modality for which it can be shown that object recognition is normal), is one that assumes that there are distinct, and disconnected, semantics for the (normal) modality of input (i.e., visual) and the (normal) modality of output (verbal).

Surely, however, all that one is justified in concluding from results such as those described here is that whatever representation is computed for objects presented in the visual modality, it is sufficient to support particular action patterns (mimes) but not the retrieval of the correct name of objects

(see Riddoch et al., 1988; Hillis et al., 1990, for further discussion of this point). Merely assigning the label of "visual semantics" to the process that supports miming performance in response to visually presented objects does not accomplish a great deal. For the notion of "visual" semantics to be more than a mere label for the observed disssociations of performance, it must at least have sufficient content that it can serve as the basis for providing a motivated explanation for the observed dissociation (as well as, of course, other relevant facts about semantics). Thus, for example, one might attempt to show how some aspect of the content (or processing structure) of "visual" semantics provides the motivation for the privileged link it has been assumed to have with those mechanisms that produce actions with objects (mime). Similarly, one must show that there is something about the specific content (or processing structure) of "verbal" semantics that justifies the assumed link with those mechanisms that produce words. As far as we can tell, no such thing has been done, leaving the claim of multiple semantics as a mere label for a dissociation of performance.

A SKETCH OF A SEMANTIC THEORY

The "model"[9] of semantic processing articulated in the course of this discussion as an alternative to the multiple semantics hypothesis, although not highly detailed, makes a number of assumptions about the structure of semantic representations and about the mechanisms for accessing this information. The principal assumptions have concerned the *organisation* of semantic information and its interaction with input and output mechanisms. For example, we have assumed a particular type of structure in the semantic system in order to account for the notion of privileged accessibility. Because of the fundamental role played by assumptions about the organisation of semantic information in any discussion of the structure of the semantic system, and because we have tried to provide some of the minimal structure needed for a nonvacuous claim about semantic processing, we have chosen to label the model proposed here the *Organised Unitary Content Hypothesis* (O.U.C.H.), instead of the more cumbersome, if perhaps more transparent, P.R.A.U.C.H.

We have argued that the O.U.C.H. model can account for those neuropsychological results that have been interpreted as evidence against unitary content accounts of the semantic system. However, because these arguments were developed in different sections of the paper they are difficult to appreciate as a coherent whole. Thus, various assumptions were

[9]We place model in quotation marks to indicate our unease with the superficial level of description we have provided for semantic structure.

introduced in the context of issues concerning questions of format of representation, questions about the nature of access procedures to semantic information, and questions about the organisation of semantic information. It may be worth the effort, therefore, to summarise briefly the principal features of the proposed model and the way it accounts for various results that have been the focus of recent attention in discussions of semantic processing.

The O.U.C.H. model assumes that the meaning of a term consists of a set of semantic predicates represented in an amodal format. For example, one might consider that meaning is specified by a set of values on an n-dimensional hypersphere, where the dimensions correspond to semantic predicates. The predicates that define the meaning of a term whose referent is an object include those features that capture the structural properties of the object—shape, texture, consistency, etc.—those that refer to the action patterns associated with the object, and those that specify the object's relations to other objects and concepts. This information may be accessed either from lexical representations in the phonological lexicon or the orthographic lexicon, or from abstract perceptual descriptions of the object (e.g. the 3-D level description in Marr's framework). By hypothesis, the *semantic* information that is accessed directly from the two types of inputs is the same[10].

Although the semantic information accessed by a word and a perceptual description of an object are the "same", the procedures for access of semantic information are not identical. An aurally or visually presented word will activate a lexical entry in the phonological or orthographic lexicon, respectively, which in turn will activate in parallel the set of semantic properties that define the meaning of the term. That is, we can think of the phonological or orthographic lexical representation as providing an address to a textured set or network of semantic predicates which jointly constitute the meaning of the word. A similar procedure is at work in the case of object recognition—the 3-D level structural description of an object will access the same network. However, and this is where the assumption of privileged accessibility comes into play, the description of an object will also allow "direct" access to those semantic predicates corresponding to salient perceptual attributes of an object (recall in this context the example of fork, where the structural description of an object can

[10]We should note that the claim here is not that the information available to the cognitive system upon presentation of an object and its name is identical in all respects. There certainly are idiosyncratic aspects of the specific object stimuli presented for recognition (e.g. its age), and for that matter for the specific form of word stimuli (e.g. spoken vs. written, spoken in anger vs. spoken calmly, and so forth) that are distinctive of the stimulus. However, this level of information is, by hypothesis, irrelevant to the issue of semantic representation. Semantics is supposed to refer to that general information that is true of all members of a class.

access the set of predicates defining the meaning of fork, but, in addition, the perceptual information about tines can directly access the semantic predicate for tines).

A further assumption of the model—the assumption of privileged relationships—is that the links relating the various predicates that comprise the meaning of a term do not have equal strengths: some links are more closely associated than others. A case in point is the following: predicates corresponding to (visual) perceptual attributes of an object and those corresponding to the canonical actions that may be performed with the object, are assumed to be closely related in virtue of the fact that the latter are determined, in part, by the former. This assumption represents a particular instantiation of a more general principle which assumes "graded" links among semantic predicates, including the one between a specific predicate and the textured set of predicates that defines the meaning of a term. In other words, semantic predicates contribute unequally in determining the meaning of a term.

Consider now the case of selective damage to the semantic system. More specifically, consider the possibility that damage to this system was such that only some of the predicates that define the meaning of a term are successfully computed upon presentation of a word or an object. What kinds of behaviour might we expect to result from such damage to the semantic system? Depending on the type of assumptions we are willing to entertain about the processing structure of other mechanisms recruited in the performance of particular tasks, we can expect to find various semantic processing impairments described in the neuropsychological literature. These include: modality-specific effects, sparing of categorisation tasks relative to identification of specific items, category-specific effects, semantic priming effects, and consistent or inconsistent item-specific effects. A very brief discussion of how each result is obtained follows.

Modality-specific Semantic Effects

Consider how the reported dissociation between naming an object and miming its use, as was reported for KE (Hillis et al., 1990), may arise from damage to the proposed unitary semantic system. By the assumption of privileged accessibility we have the result that in specific conditions of brain damage we expect that words and objects may result in an asymmetric activation of the semantic properties that comprise the meaning of a term. Specifically, when the stimulus is an object there is a greater probability of successfully activating the semantic predicates corresponding to the perceptual properties that define an object than is the case when the stimulus is a word. Given that we may have more information about the semantic predicates of perceptual attributes when the stimulus is an object than when it is a word, and given the assumption of privileged relationships, there is a greater probability of activation of the semantic predicates of canonical actions when the stimulus is an object than when it is a word. Thus, selective damage to the semantic system *uniformly* (or randomly) affecting stored representations may result in a dissociation between miming and naming of objects.

In the case of so-called optic aphasia (or other modality-specific aphasias), we can assume that there is a selective (modality-specific) deficit in computing full semantic representations from the (3-D) structural description of objects. However, given the principle of privileged accessibility, which assumes that semantic predicates referring to perceptual attributes may be directly accessed from individual perceptual features of an object, it is possible to access some semantic information even when the structural description of the object as a whole fails to activate its corresponding full semantic representation. And, given the principle of privileged relationships, access to semantic predicates of perceptual attributes facilitates the activation of closely related (not necessarily perceptual) semantic predicates. Consequently, we have a situation where the quantity/quality of semantic information computed from a visually presented object may be insufficient to produce the name of the object, but the same quantity/quality of semantic information may be sufficient to support tasks such as miming (see Hillis et al., 1990, for more discussion).[11]

Relative Sparing of Categorisation Performance

The reported pattern of spared ability to classify an object or a word as a member of a superordinate category and impaired ability to provide the object's name or identify specific properties of a word, is also an expected consequence of damage to the O.U.C.H. model. This type of dissociation may reflect no more than the difference between the amount and/or type of semantic information that is sufficient to support categorisation performance (e.g. deciding that a fork is a kitchen utensil) versus the amount and/or type of semantic information that is needed to support naming or identification of specific properties of a word (e.g. deciding that the referent of a word is large relative to some standard). On the assumption of uniform damage to semantic predicates, and the assumption that different

[11]It should be noted that the model discussed here is one instantiation of a large class of possible unitary content hypotheses of the semantic system. There are many different ways of implementing the relationship between the activation of semantic predicates and the mechanisms that are engaged in performing an action. We have chosen to make the plausible assumption that there is a privileged link between semantic predicates for perceptual and action attributes of an object. However, depending on the model of action one is willing to entertain, there are other possibilities.

amounts and/or types of information are needed to support accurate performance on different tasks, better performance on categorisation than naming or identification of specific properties of a word is an expected result of the O.U.C.H. model (see Rapp & Caramazza, 1989, for similar conclusions).

Category-specific Effects

If instead of assuming uniform (or random) damage to the information stored in the semantic system we were to assume, instead, dishomogeneous damage, we would then expect category-specific effects in naming or other tasks involving semantic processing. By dishomogeneous we mean a deficit that disproportionately affects related semantic features. Because, by hypothesis, the meaning of a term consists of a set of predicates, damage that selectively affects specific predicates will result in impairment to all those terms whose meaning includes the predicates in question—in other words, a category-specific effect.

Semantic Priming Effects

A pattern of performance characterised by "spared" semantic priming effects in lexical decision tasks in the face of impaired performance in semantic classification tasks has been interpreted as undermining the hypothesis that poor performance in semantic classification reflects damage to the semantic system (Milberg, Blumstein, & Dworetzky, 1987)[12]. However, the reasoning on which the authors based this conclusion is suspect. It requires that we accept a hidden premise whose truth is not uncontestable; viz., that the semantic structure needed to support "normal" semantic priming effects is (at least) equivalent to that needed to support accurate performance in semantic classification or naming tasks. If this assumption were false, then, the presence of semantic priming in lexical decision tasks need not be taken to mean that the semantic system is undamaged. And, on the more plausible assumption that semantic priming effects may be supported by *less* structure or information than that needed for most lexical semantic tasks, the reported dissociation would lose its paradoxical status. This is the same type of argument as the one just presented in the case of the putatively paradoxical preservation of category-level performance in the face of impaired ability to recognise

[12]Of course, there are cases when poor performance in classification tasks does not result from semantic impairment but from damage to perceptual or other lexical processing components. Here, however, we are considering those cases where there is no indication of damage to these latter components. The focus is on the reasoning that would support the contention that the presence of semantic priming effects rules out damage to the semantic system.

specific properties of a term. In both cases, the O.U.C.H. model predicts the dissociation so long as the damage to the semantic system is only partial (see Rapp & Caramazza, in press, for detailed discussion).

Consistent or Inconsistent Item-specific Effects

Does damage to the semantic system lead to consistent or inconsistent performance on repeated tests with specific items? What are the expectations from the O.U.C.H. model? No expectations may be derived from the O.U.C.H. model without further assumptions about the structure of access procedures and specific assumptions about possible forms of damage to the hypothesised system. As things now stand, both consistent and inconsistent performance may be observed. However, in no way would either outcome indicate whether the impairment results from damage to "access versus degraded storage of information". Either outcome is consistent with either hypothesis about the nature of the deficit when appropriate processing assumptions are made. Thus, for example, consider the case of damage that affects the stored semantic representations in such a way that the computed representation for a word does not specify its full set of predicates. Do we expect consistent or inconsistent performance with the item in question? Certainly, a possible outcome is consistent wrong performance—the computed information is never enough to activate the correct lexical output forms. However, an equally possible outcome is inconsistent performance—the computed representation is sufficient to activate the correct *and* related responses in roughly equal extents, resulting in inconsistent responses from trial to trial. The dichotomy between access and storage deficits may only be addressed meaningfully (if at all) in the context of a sufficiently specific model of semantic processing. In other words, the issue itself is of dubious theoretical value in the absence of a reasonably articulated theory of semantic representation and processing. There is no theoretically well-formed issue about a possible *general* contrast between access and storage deficits. And, therefore, contrary to recent discussions of this matter (Shallice, 1987), there can be no a priori set of empirical criteria that could serve to identify those patients in whom the deficit is to access mechanisms and those in whom the deficit is in the storage of information.

CONCLUSIONS

In this discussion we have shown that the cluster of notions that have been introduced under the general rubric of "multiple semantics" are not clear enough to provide the basis for serious empirical evaluation. We have argued that where the fundamental distinctions within this framework—

viz., among such notions as "visual", "tactile", and "verbal" semantics—have been used in an effort to account for experimental results, these have resulted in no more than the mere labelling of observed dissociations. We have also shown that it is possible to formulate unitary content models of semantic processing that are consistent with the evidence which supposedly required postulating distinct semantic systems. The O.U.C.H. model not only accounts for reported modality-specific effects, but also provides a framework for interpreting various other seemingly paradoxical results.

Our negative assessment of some of the "theoretical" discussions of semantics in the context of cognitive neuropsychological research should not be interpreted as pessimism about the value of the research in this area. To the contrary, as pointed out earlier, there remains the fact that the performance of brain-damaged patients continues to provide important opportunities for the development of detailed models of cognitive functioning. The problem is not with the data, it is with the "theories". So long as theories are no more than labels for dissociations we cannot expect to have a coherent research program in experimental semantics. It is our hope that this discussion has served to bring to the foreground some of the assumptions underlying the currently debated hypotheses in such a way that more clearly articulated and possibly empirically distinguishable claims will follow.

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